CLAIMS

What is claimed is:

1. A self-powered microthermionic converter comprising:
   an emitter electrode;
   a collector electrode separated from said emitter electrode by a micron-scale interelectrode gap;
   a self-powered thermal power source in thermal contact with said emitter electrode;
   means for removing electrons emitted by the emitter electrode; and
   means for returning the emitted electrons to the collector electrode.

2. The microthermionic converter of claim 1, wherein said interelectrode gap is less than about 10 µm.

3. The microthermionic converter of claim 2, wherein said interelectrode gap is between approximately 1µm and approximately 10µm.

4. The microthermionic converter of claim 3, wherein said interelectrode gap is between approximately 1µm and 3µm.

5. The microthermionic converter of claim 1, wherein said interelectrode gap comprises a vacuum.

6. The microthermionic converter of claim 1, wherein said interelectrode gap comprises an encapsulated, low pressure, vapor system, wherein the vapor coats the electrode surfaces, resulting in a reduced work function.

7. The microthermionic converter of claim 6, wherein said vapor is selected from the group consisting of cesium and barium vapors.

8. The microthermionic converter of claim 1, wherein said thermal power source comprises a radioactive isotope.

9. The microthermionic converter of claim 8, wherein said radioactive isotope comprises an alpha-emitting isotope selected from the group consisting of Curium-242, Curium-244, and Polonium-210.

10. The microthermionic converter of claim 1, wherein a thermionic emissive material is used in the composition of an electrode selected from the group consisting of the emitter electrode and the collector electrode.

11. The microthermionic converter of claim 10, wherein the thermionic emissive material comprises an alkaline earth oxide.

12. The microthermionic converter of claim 11, wherein the alkaline earth oxide comprises at least one material selected from the group consisting of barium oxide, strontium oxide, and calcium oxide.

13. The microthermionic converter of claim 11, wherein the thermionic emissive material further comprises an adjunct oxide selected from the group consisting of aluminum oxide and scandium oxide.

14. The microthermionic converter of claim 11, wherein the thermionic emissive material further comprises a metal selected from the group consisting of tungsten, rhenium, osmium, iridium, ruthenium, osmium, iridium, and mixtures thereof.

15. The microthermionic converter of claim 11, further comprising a metal capping layer disposed on the thermionic emissive material, wherein the metal capping layer comprises a material selected from the group consisting of scandium, scandium oxide, and mixtures thereof.

16. The microthermionic converter of claim 11, wherein the environment in the interelectrode gap comprises a vacuum.

17. The microthermionic converter of claim 11, wherein the thermionic emissive material comprises a material selected from the group consisting of tungsten, molybdenum, tantalum, tungsten oxide, molybdenum oxide, tantalum oxide, and mixtures thereof.

18. The microthermionic converter of claim 17, wherein the environment in the interelectrode gap comprises a vapor selected from the group consisting of cesium and barium vapors.

19. The microthermionic converter of claim 1, wherein a length of said emitter electrode is less than approximately 200μm.

20. The microthermionic converter of claim 19, wherein said emitter electrode length is between approximately 50μm and approximately 200μm.

21. The microthermionic converter of claim 20, wherein said emitter electrode length is between approximately 50μm and approximately 100μm.

22. The microthermionic converter of claim 1, additionally comprising a thermal heat barrier.

23. The microthermionic converter of claim 22, wherein said thermal heat barrier comprises a micro heat barrier comprising a plurality of microspikes and at least one highly IR reflective surface.

24. The microthermionic converter of claim 1, additionally comprising an electrically insulating material disposed between non-interacting portions of said emitter electrode and collector electrode.

25. The microthermionic converter of claim 1, wherein a temperature for operation is between approximately 850K and approximately 1200K.

26. The microthermionic converter of claim 25, wherein said temperature for operation is between approximately 1100K and approximately 1200K.

27. The microthermionic converter of claim 1, wherein said collector electrode and emitter electrode comprise a diode.

28. The microthermionic converter of claim 1, additionally comprising a fuel cup.

29. The microthermionic converter of claim 28, wherein said fuel cup comprises an outer surface and said outer surface is coated with a thermionic emissive material comprising said emitter electrode.

30. A method of converting heat to electrical energy using thermionic electron emission comprising the steps of:

providing an incorporated thermal power source that is in thermal contact with an emitter electrode;

heating the emitter electrode with the incorporated thermal power source, thereby causing electrons to be emitted from the emitter electrode;

streaming electrons emitted from the emitter electrode across a micron-spaced interelectrode gap to a collector electrode;

collecting the electrons reaching the collector electrode;

providing the collected electrons to an external electrical load; and

returning the electrons to the emitter electrode, thereby completing an electrical circuit.

31. The method of claim 30, wherein thermal power source comprises a radioisotope.

32. The method of claim 31, wherein the radioisotope comprises an alpha-emitting radioisotope from the group consisting of Curium-242, Curium-244, and Polonium-210.

33. The method of claim 30, wherein the step of placing an incorporated thermal power source in thermal contact with an emitter electrode comprises enclosing the power source within the emitter electrode.

34. The method of claim 30, additionally comprising the step of utilizing a heat barrier on the non-diode regions of the thermal source.

35. A method of manufacturing a self-powered microthermionic converter comprising the steps of:

providing a thermally and electrically insulating material as a substrate;

forming at least one fuel cup having an outer surface from the substrate through micromachining techniques;

depositing at least one thermionic electron emissive layer on the outer surface of the fuel cup to provide an emitter electrode;

forming a collector electrode by depositing at least one layer of a thermionic electron emissive material on the substrate while maintaining a micron-spaced interelectrode gap between the collector electrode and emitter electrode; and

placing a thermal power source inside the fuel cup.

36. The method of claim 35, wherein the thermal power source comprises a radioisotope.

37. The method of claim 36, wherein the radioisotope comprises an alpha-emitting radioisotope from the group consisting of Curium-242, Curium-244, and Polonium-210.

38. The method of claim 35, further comprising enclosing the fuel source within the emitter electrode.

39. The method of claim 35, further comprising the step of disposing a thermal heat barrier internally on the base of the fuel cup.

40. The method of claim 35, wherein the interelectrode gap is less than about 10μm.

41. The method of claim 40, wherein the interelectrode gap is between approximately 1μm and approximately 10 μm.

42. The method of claim 41, wherein the interelectrode gap is between approximately 1μm and approximately 3μm.

43. The method of claim 35, further comprising providing a vacuum in the micron-spaced interelectrode gap.

44. The method of claim 35, wherein the step of providing a micron-spaced interelectrode gap between the collector electrode and emitter electrode comprises providing a low pressure vapor within the micron-space interelectrode gap, wherein the vapor coats the electrode surfaces, resulting in a reduced work function.

45. The method of claim 35, wherein the vapor is selected from the group consisting of barium and cesium vapors.

46. The method of claim 35, additionally comprising the step of forming a fuel cup and forming a collector electrode by using micromachining techniques.

47. The method of claim 35, wherein the step of disposing at least one thermionic electron emissive layer on an outer surface of the fuel cup to provide a emitter electrode is through vapor deposition.

48. The method of claim 35, additionally comprising the step of incorporating the converter in a micromachine or microcircuit.

49. The method of claim 35, wherein the step of forming a fuel cup additionally comprises the steps of:

forming a fuel grid;

inserting the thermal power source in the fuel cup;

capping the fuel cup; and

dissolving the fuel grid.

50. The method of claim 49, wherein the step of inserting the thermal power source in the fuel cup comprises inserting a radioisotope as the thermal power source.

51. The method of claim 50, wherein the step of inserting the thermal power source in the fuel cup comprises inserting an alpha-emitting radioisotope selected from the group consisting of Curium-242, Curium-244, and Polonium-210.

52. The method of claim 49, wherein the step of capping the fuel cup comprises capping the fuel cup with a non-reactive metal.

53. The method of claim 52, wherein the step of capping the fuel cup comprises capping the fuel cup with gold.

54. The method of claim 52, wherein the step of capping the fuel cup comprises capping the fuel cup with a highly reflective, non-reactive material.

55. The method of claim 49, wherein the step of forming a fuel grid comprises fabricating a precision grid having dissolvable source buckets.